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How clean energy and efficiency can replace coal for a reliable, modern electricity grid

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ABSTRACT

Aging coal-fired power plants are retiring all over the country, presenting the U.S. with an exciting opportunity to lead a global transition to a clean energy economy. The move away from coal begs the question: What will replace it? Energy efficiency, renewable energy and electric grid modernization should play an important part in replacing retiring coal capacity, and thereby mitigate the rush to build new natural gas plants.

1. Introduction

The move away from coal raises an urgent question: what will replace it? And, by extension, what kind of generation will the United States move toward? This article argues that the shift from coal provides the nation with an historic opportunity to lead a global transition to a clean energy economy and to put more Americans to work in the energy efficiency and renewable technology sectors. Renewable energy and energy efficiency avoid many environmental and price volatility concerns associated with continued reliance on fossil fuels, and when they are paired with new demand response and grid planning efforts—such as transmission upgrades and distributed storage—they can be every bit as reliable as natural gas. The article outlines three major opportunities—energy efficiency, renewable energy, and electric grid modernization—that can replace retiring coal-fired power plants without recourse to new natural gas plants, and summarizes some of the many economic and environmental benefits these clean energy technologies can provide. The article then gives examples of specific clean energy opportunities for the Pennsylvania-New Jersey-Maryland (PJM) Interconnection, the Midwest Interconnection System Operator (MISO), and the Southeast, the three electricity grid regions where the majority of U.S. coal plant retirements are occurring.

2. Energy efficiency is the most cost-effective available resource

The United States has massive untapped potential to save energy and money through more efficient appliances, buildings, lighting, and more—delivering the same quality services with less electricity consumption and spending.[1] Saving electricity is proven to be the most cost-effective way to meet our energy needs (although, as noted below, wind and solar energy are also rapidly emerging as a more cost-effective alternative to fossil-fueled generation in some areas).[2] By requiring electric utilities to implement programs that remove market barriers preventing individuals and businesses from choosing the most efficient option, states can cut energy demand and avoid the need for big investments in natural gas power plants and transmission infrastructure.[3] Regional transmission organizations (RTOs) like the PJM Interconnection and the Midcontinent Independent System Operator (MISO) can also operate such programs.

To understand how large the potential to save electricity is, consider energy efficiency programs in leading states like Rhode Island and Massachusetts. These two states have cost-effectively achieved electricity savings close to or over 3% of sales. In other words, the total energy savings of the devices and projects utilities put in place will, in their first year of operation, save around or more than 3% of electricity sales. These efficiency leaders achieved 3.27% and 2.85% energy savings in 2015, respectively, and have been consistently achieving high savings rates for the past few years.[4] In comparison, 20 states have yet

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[1] While the discussion focuses on savings opportunities in the electric sector, it is worth noting that energy efficiency programs can also target natural gas use in the residential, commercial, and industrial sectors. Several states have both electricity and natural gas efficiency programs.

[2] American Council for an Energy Efficient Economy New (ACEEE) Report Finds Energy Efficiency Is America's Cheapest Energy Resource Mar ch 2014 Lazard, Levelized Cost of Energy Analysis—Version 9.0, November 2015; Sheryl Carter, Scaling Up Energy Efficiency: Saving Money, Creating Jobs, and Slashing Emissions, Natural Resources Defense Council (NRDC) March 2013

[3] NRDC, Doing More and Using Less: Regulatory Reforms for Electricity and Natural Gas Utilities Can Spur Energy Efficiency, January 2011.

[4] Savings calculated using EIA Form 861 Sales and Savings Data for 2015. See EIA (2016). Electric power sales, revenue, and energy efficiency Form EIA-861 detailed data files.

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to exceed annual efficiency savings of 0.6% of electricity sales.[5]

Promoting energy efficiency is the best way to keep electricity bills low for all consumers.[6] Energy efficiency directly reduces bills by reducing electricity consumption. It also suppresses wholesale electricity and capacity prices by minimizing total energy demand during peak times (e.g., a hot summer afternoon). This reduces the need to dispatch the generators with the highest operating costs, lowering the market price of electricity for all customers.[7] And importantly, by targeting low-income households, states can take steps to ensure that these benefits are maximized for those already facing the greatest energy burden.[8]

States that are just coming around to the benefits of this untapped resource can follow the lead of efficiency trailblazers like Rhode Island and Massachusetts because the regulatory framework that drives the significant energy savings in high-performing states is not state-specific. For example, smart regulatory policies in both Rhode Island and Massachusetts include adopting mechanisms that remove the disincentive for utilities to invest in any measures that would reduce their electricity sales. For instance, one approach is to include timely recovery of lost revenues through revenue decoupling—i.e., removing the disincentive for utilities to support energy-savings programs and ensuring that utilities recover authorized costs of service regardless of fluctuations in sales. Another approach is to grant timely cost recovery through customer rates—i.e., allowing utilities to recover their costs of delivering energy efficiency programs.[9] Utilities in these pioneering states also invest in well-designed programs that, among other things, offer rebates on the purchase price of energy-efficient appliances and equipment and work with retailers and distributors to make sure that customers know about efficient options and have access to them. The biggest utility programs help residential and commercial customers install efficient LED lighting by working with retailers, electrical contractors, and lighting designers to make these already cost-effective options even more attractive to consumers.[10]

Requiring that utilities invest in cost-effective energy efficiency programs has also been shown to unlock significant savings opportunities. For instance, Rhode Island invests a greater proportion of utility revenues in energy efficiency than any other state, primarily because instead of imposing arbitrary limits on monetary investment in efficiency programs or eligible customers, it requires that utilities invest in all cost-effective energy efficiency (energy efficiency that costs less, averaged over its lifetime, than the generation it replaces or avoids). Massachusetts does the same. In both states, electric utilities must save energy whenever it costs less than building new power plants or other costly infrastructure.[11]

In addition to the all-cost-effective mandate, Rhode Island and Massachusetts also do not allow large customers to opt out of contributing to the cost of energy efficiency programs, a practice that hinders savings in other states. Rather, they ensure that the programs include well-designed industrial opportunities that are tailored to deliver real cost savings to that very sector.[12] States that are still achieving low levels of savings should follow these best practices by adopting strong state energy savings goals and providing adequate funding to achieve them, designing programs based on the successful initiatives in leader states and their own, state-specific environments. The good news is that studies are showing that states with more recent energy efficiency legislation and regulatory activity have been able to quickly make up ground and are achieving savings comparable to states with much more mature efficiency regulatory programs.[13] For example, Arizona began expanding its energy efficiency programs only a decade ago, in contrast to states like California, Iowa, Massachusetts, Minnesota, and Wisconsin, which have had large-scale efficiency programs in place since the 1980s. Yet in 2013 Arizona became the state with the fourth-highest annual electricity savings in the country, with savings reaching an impressive 1.74% of retail sales from roughly 0.2% in 2006, according to ACEEE.[14] All states, regardless of historical performance, could boost programs to save energy and help achieve state and national climate and clean energy goals.

While much progress has been made on efficiency investments, large and cost-effective opportunities to reduce energy demand still exist against a backdrop of increasing coal plant retirements. In fact, various analyses have found that by 2050, cost-effective energy efficiency opportunities can collectively reduce energy use by 40 to 60% relative to the EIA 2015 demand forecasts.[15] Energy efficiency is already the most cost-effective and smart investment states can make to meet electricity demand, and its potential will become even greater as new energy saving technologies penetrate the market. For instance, the widespread commercial deployment of LED lighting technology for troffer light fixtures—the most common type of fixture in commercial and institutional buildings—could by itself generate 2.2% savings in national electricity use over the next decade.[16] Many regions are already incorporating efficiency into long-term resource planning. For example, the resource planning modeling for the new Northwest Power Plan for Idaho, Montana, Oregon, and Washington uses energy efficiency and demand response to fulfill nearly all projected growth in energy and capacity needs through 2035, even as the region retires coal capacity due to market forces, age, and regulations.[17] Energy efficiency is also a low-cost way to maintain regional reliability.[18] In fact, both ISO-New England—the Independent System Operator for New England and PJM have evaluated the reliability of energy efficiency programs to reduce demand. ISO-New England found that energy efficiency providers delivered significantly more peak demand savings than they had originally committed, and both ISO-New England and PJM concluded that energy efficiency has been the most reliable of all of the resource types that have committed to supply capacity in recent years.[19]

[5] E.I.A. 2016 Electric power sales, revenue and energy efficiency Form EIA-861 detailed data files

[6] 201 4 Tim Woolf, Erin Malone, and Jenn Kallay, Rate and Bill Impacts of Vermont Energy Efficiency Programs, Synapse Energy Economics, April 2014; George Katsigiannakis and Himanshu Pande, PJM 2019/2020 Capacity Auction Analysis, ICF, International, July 2016.

[7] A Texas study that found that voluntary AC cycling programs would have saved $200 million over just the summer of 2011, and $85 million alone on the peak day of the summer. South-Central Partnership for Energy Efficiency as a Resource (2015). Incremental Demand Response Study: ERCOT Case Study.

[8] Ariel Drehobl and Lauren Ross, Lifting the High Energy Burden in America's Largest Cities, 2016

[9] Devra Wang et al., Doing More and Using Less: Regulatory Reforms for Electricity and Natural Gas Utilities Can Spur Energy Efficiency, NRDC, January 2011, https://www.nrdc.org/sites/default/files/doingmoreusingless.pdf.

[10] Katherine Tweed A Boom in Utility Rebates Drives LED Lighting, GreenTech Media, September 2012, https://www.greentechmedia.com/articles/read/A-Boom-inUtility-Rebates-Drives-LED-Lighting.

[11] ACEEE's State and Local Policy Database for more details on individual state EERS policies.

[12] Williams, Samantha, et al (2015). Stemming the Tide of Industrial Opt-Outs. ACEEE Summer Study on Energy Efficiency in Industry.

[13] Robert Neumann et al., Regulatory Update: A Twenty-State Review of Regulatory Regimes and Effective Energy Efficiency Programs Navigant Consulting 2016

[14] ACEEE, The 2013 State Energy Efficiency Scorecard.

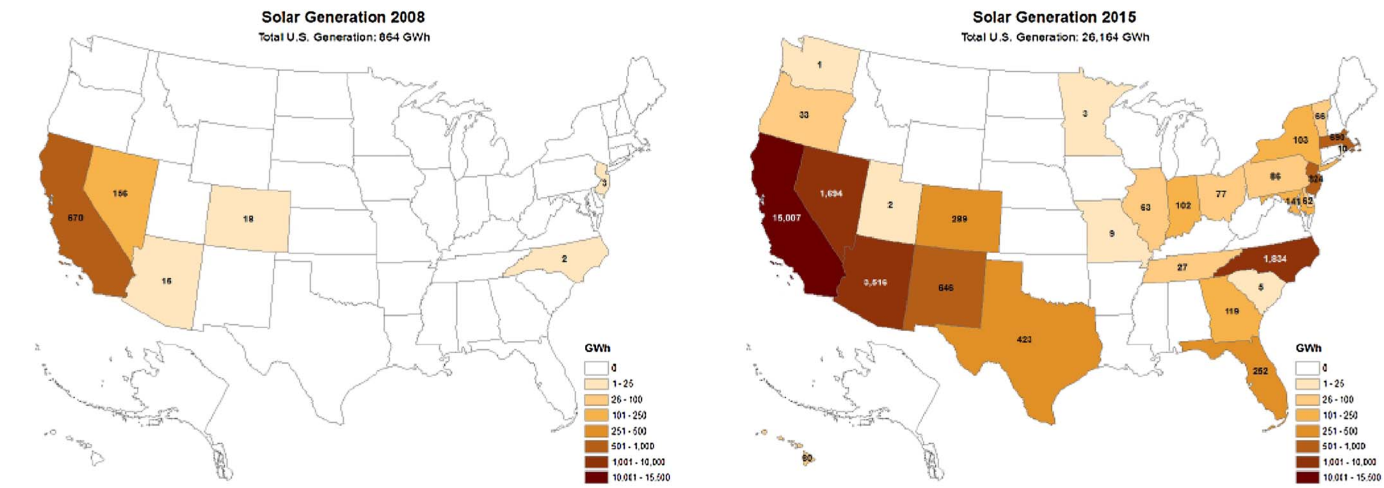
[15] Steven Nadel, Neal Elliott, and Therese Langer, Energy Efficiency in the United States: 35 Years and Counting, ACEEE, June 2015; Paul J. Hibbard, Katherine A. Franklin, and Andrea M. Okie, The Economic Potential of Energy Efficiency: A Resource Potentially Unlocked by the Clean Power Plan, Analysis Group, Inc., December 2014.

[16] Chris Neme and Jim Grevatt, The Next Quantum Leap in Efficiency: 30 Percent Electric Savings in Ten Years, RAP and Energy Futures Group, February 2016.

[17] Northwest Power and Conservation Council, Seventh Northwest Conservation and Electric Power Plan, February 2016.

[18] Monitoring Analytics, Analysis of the 2019/2020 RPM Base Residual Auction, August 2016.

[19] Regulatory Assistance Project, Energy Efficiency Participation in Electricity Capacity Markets: The U.S. Experience Montpelier, VT: The Regulatory Assistance Project, September 2014.



Source: NRDC

Fig. 1. Growth in Electricity Generated From Utility-Scale Solar, 2008–2015.

3. Clean energy is already cost competitive

The power sector game is changing. And fast. In the past seven years alone, the all-in costs of generating electricity from wind and solar—-including capital outlay, operation and maintenance costs, and financing—have dropped by a whopping 66% and 85%, respectively.[20] These plummeting technology costs, coupled with growing demand for renewables to meet state renewable energy standards, have driven significant increases in wind and solar generation over the past eight years (Figs. 1 and 2). Between 2008 and 2015, total U.S. wind generation more than tripled, while 2015 total solar generation was 30 times what it was in 2008. Goldman Sachs heralds wind as “the cheapest source of incremental power” and notes that “the cost to produce solar power is reaching, and in some cases beating, the costs of fossil fuel sources.”[21]; In fact, 2016 was expected to be the best year on record for solar energy in the U.S. As of last fall, solar represented 40% of all capacity added in 2016, and more than a cumulative 14 GW of solar projects was expected to be installed by the end of the year—a whopping 88% increase from 2015.[22] At the same time, the near-term growth outlook for wind and solar energy has never been better. In December 2015, Congress passed multiyear extensions for tax credits for wind and solar technologies, providing important near-term certainty for the clean energy industry. Industry experts expect these tax credits to drive unprecedented growth in wind and solar energy in the next five years. Bloomberg New Energy Finance projects that wind and solar capacity will grow by a whopping 59% and 233% from 2015 levels, respectively, by 2021.[23] This significant growth is expected to be driven by tax credit extensions, growing demand for renewable energy to satisfy state renewable energy portfolios, and plummeting technology costs.

The projected near-term growth in clean energy could also be an economic boon to states that embrace it. Developers will be deciding where to site projects, bringing with them new jobs and revenues from tax and land lease payments.[24] This would largely benefit rural communities and low-income counties; already the wind industry pays $222 million a year to farming families and rural landowners to install wind farms on parts of their land.[25] States with strong clean energy policies—including well-designed renewable portfolio standards (RPS)—will attract the new investments, benefiting their state economies.[26] In light of the significant cost reductions, as well as federal and state policy support, power companies in California, Texas, and other areas of the Southwest have reported a readily available supply of solar procurement bids at less than $40 per megawatt-hour (MWh), and power companies purchased wind power at an all-time-low average of $20/MWh in 2015.[27] (Wind developers purchased wind power in the range of $19–$35/MWh in windy regions like Texas and the Midwest.) In fact, in some areas of the country it is now cheaper to build a *new* wind or solar project than it is to run an *existing* fossil fuel-fired power plant. For example, recent analysis in Colorado found that it would be cost-effective for Xcel Energy to replace 6000 GWh of older coal generation with 2000 MW of *new* wind.[28] Many states are already reaping the benefits of renewable energy. Existing RPS have reduced carbon emissions and air pollution, cut water use, and created hundreds of thousands of clean jobs at little or no cost to households and businesses.[29] In fact, over the past decade, the 10 leading renewable energy states have seen smaller retail electricity rate increases than the 10 states with the least renewable generation.[30] Additionally, because of their near-zero operating costs, wind and solar bid low into the power markets, reducing run times for more expensive generators and driving

[20] Lazard, Levelized Cost of Energy Analysis 10.0, December 2016.

[21] Goldman Sachs, The Low Carbon Economy: Part of the Answer Is Blowing in the Wind, June 30, 2016; Goldman Sachs, The Low Carbon Economy: Here Comes the Sun, August 28, 2016.

[22] Mike Munsell, In Its Largest Quarter Ever, US Solar Market Saw Nearly 2 MW of PV Installed per Hour in Q3 2016, GreenTech Media, December 2016; Anmar Frangoul, Records broken as US solar installations surge, CNBC, December 2016.

[23] Amy Grace et al., Bloomberg New Energy Finance, Impact of Tax Credit Extensions for Wind and Solar, December 2015.

[24] Union of Concerned Scientists, Benefits of Renewable Energy Use.

[25] American Wind Energy Association, Wind Power Pays $222 Million a Year to Rural Landowners, March 2016.

[26] LBNL (2016). A retrospective analysis of the benefits and impacts of US renewable portfolio standards. Lawrence Berkeley National Laboratory.

[27] James Ayre, Palo Alto, California, Approves Solar PPA with Hecate Energy at $36.76/MWh! (Record Low), Cleantechnica, February 2016; Stephen Lacey, Cheapest Solar Ever: Austin Energy Gets 1.2 Gigawatts of Solar Bids for Less Than 4 Cents, Greentech Media, June 2015; Christopher Martin, Buffett Scores Cheapest Electricity Rate with Nevada Solar Farm, Bloomberg, July 2015; Ryan Wiser and Mark Bolinger, 2015 Wind Technologies Market Report, Lawrence Berkeley National Laboratory, August 2016; Bloomberg New Energy Finance, Factbook: A Landmark Year for US Energy Evolution, February 2016.

[28] Ron Lehr, Analysis Finds Wind Could Replace 6000 Gigawatt-Hours of Coal in Colorado, Greentech Media, August 2016.

[29] LBNL and NREL., A Retrospective Analysis of the Benefits and Impacts of U.S. Renewable Portfolio Standards, Lawrence Berkeley National Laboratory and National Renewable Energy Laboratory, January 2016.

[30] Nancy Pfund and Anand Chhabra, Renewables Are Driving Up Electricity Prices—Wait What? DLB Partners, March 2015.

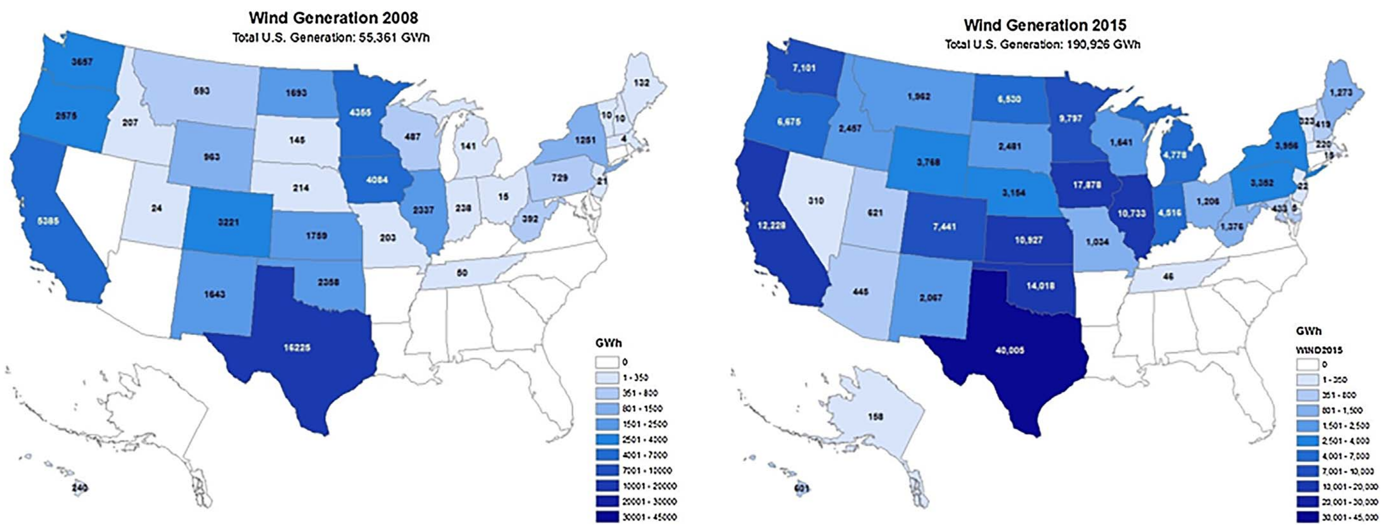


Fig. 2. Growth in Electricity Generated From Wind, 2008–2015.

down wholesale electricity prices and natural gas prices (because of the lower demand for natural gas in the power sector).[31] At the same time, clean energy investments have been an economic boon to states and the country as a whole. Per MW of capacity, renewable energy generation (and energy efficiency) creates more jobs than fossil generation. In fact, in its recently published Energy Employment Report, the U.S. Department of Energy estimates that, in 2016, the U.S. solar industry employed more than 350,000 people, which exceeds the combined employment of coal, gas, and oil workers in the power generation sector (the fossil fuel industry employed just under 200,000 workers). Similarly, the wind energy workforce increased to more than 100,000 across the nation, twice the number recorded in 2013 by the American Wind Energy Association. Maximizing investments in clean energy will also benefit households and businesses, as installing wind and solar projects becomes more and more cost-effective.[32] Wind project costs are projected to decline by 24–30% by 2030, and 35–41% by 2050, relative to 2014.[33] At the same time, a recent industry report concluded that solar installations will drop to \$1 per watt by 2020, low enough for solar to directly compete with coal and natural gas.[34] Regions across the country are integrating large amounts of renewables in their grids as a consequence of increasingly attractive economics and other measurable benefits of wind and solar projects. Iowa now generates more than 30% of its power with wind and will be the first state in the country to reach the 40% mark once the recently announced 2 GW of wind projects are completed. At the same time, Iowans enjoy some of the lowest electricity prices in the country.[35] In Colorado, Xcel Energy averaged 55% wind penetration over a full day in October.[36] In California, the California Independent System Operator (CAISO) keeps breaking records, with utility-scale solar and other renewables meeting 54%–56% of the system's electricity needs for periods of time in May earlier this year.[37] There have been many more recent examples of clean energy leadership. Illinois and Michigan both passed important legislation to boost their renewable energy standards. Gov. John Kasich of Ohio vetoed an attempt to delay implementation of Ohio's clean energy standards. And, five states—California, New York, Hawaii, Oregon, and Vermont—and the District of Columbia, home to one-fifth of the country's population, now intend to get at least 50% of their electricity from renewable sources. A recent study by Lawrence Berkeley National Laboratory found that in 2013 alone, RPS across the country saved customers \$1.3–\$1.7 billion from lower natural gas prices (as a result of lower demand for natural gas across the power sector). The same study estimated that RPS also supported nearly 200,000 renewable energy-related jobs, provided \$5.2 billion in health benefits through improved air quality, and resulted in global climate benefits of \$2.2 billion. Cost-effective renewable energy investments are delivering significant benefits across the country. States have increasing opportunities to capture these benefits as the shift away from fossil fuel-fired power continues.

4. Smart planning will strengthen grid reliability

Wind and solar resources are variable, and their peak generating times may not align with the times of highest electricity demand. Fortunately, electricity system planners have many tools at their disposal to reliably integrate large amounts of these resources into the grid. With smart investments in effective dispatch planning, transmission upgrades, demand response, advanced metering infrastructure, and other distributed energy resources like battery storage, the U.S. electric grid can get the upgrades it needs to facilitate an even quicker clean energy boom. System operators and utilities such as ERCOT in Texas and Xcel Energy in Colorado are already integrating high levels of renewables by using shorter dispatch and transmission cycles, improved wind forecasting technology, and proactive transmission planning. For example, the transmission projects under ERCOT's Competitive Renewable Energy Zones (CREZ) initiative were able to send more than 18,000 MW of wind power across the state with little to no wind curtailment (i.e., reduction of available output due to factors such as inadequate transmission, local congestion, or excessive supply during low-load periods). In fact, the new transmission lines have nearly zeroed out the need to curtail wind generation, with curtailment dropping from 17% in 2009 to 0.5% in 2014 while wind generation increased by roughly 75% over the same time period.[38] As the successful CREZ initiative phases out, ERCOT is proactively looking at new transmission expansion programs to allow wind from newly developed

[31] Ryan Wiser et al., A Retrospective Analysis.

[32] Lazard, Levelized Cost of Energy Analysis.

[33] Ryan Wiser et al., Forecasting Wind Energy Costs & Cost Drivers, Lawrence Berkeley National Laboratory & The National Renewable Energy Lab, June 2016.

[34] Ben Gallagher, U.S. Solar PV Price Brief H1 2016: System Pricing, Breakdowns and Forecasts, GTM, Research, June 2016.

[35] Office of the Governor of Iowa, Branstad, Reynolds Announce Over 31 Percent of Iowa Electricity Now Supplied by Wind, February 2016; Katharine McCormick, Iowa Okays the Nation's Largest Wind Build, NRDC, September 2016; Sustainable Business, Iowa Will Soon run on 40% renewable energy, June 2016.

[36] Xcel Energy, Wind Power.

[37] Zachary Shahan, California Breaks Solar Record (Again), Enough Electricity for 2 Million Homes, Clean Technica, July 2016.

[38] Ryan Wiser and Mark Bolinger, 2014 Wind Technologies Market Report, US Department of Energy, 2014.

wind farms in the Texas panhandle to flow to load centers.[39] At the same time, spreading out renewable resources like solar and wind over larger geographic areas decreases their variability, improves forecasting, and minimizes the need to quickly ramp up fossil generation to respond to changing conditions.[40] An increasing body of research is demonstrating how these integration techniques can be used to massively increase renewable penetration. A Southwest Power Pool (SPP) wind integration study proposed several transmission and reliability recommendations that "would enable the SPP transmission system to reliably handle up to 60% wind penetration levels."[41]; At a broader scale, a 2016 article in *Nature* demonstrated that an integrated national grid could use optimally placed renewables to completely phase out coal use and decrease natural gas generation below current levels.[42] Upgrades to the country's transmission infrastructure at both the bulk system and distribution levels, along with efforts to promote more rapid and lower-cost interconnection between regions, can reliably facilitate extremely high levels of renewable generation.[43] In fact, a recently released Eastern Renewable Generation Integration Study (ERGIS) confirmed yet again that expanding transmission infrastructure to wind- and solar-rich areas can reliably unlock more than 10 times the current amount of wind and solar on the Eastern Interconnect power system.[44] Beyond supply-side planning and traditional energy efficiency programs, we can also improve renewable integration through demand response and dynamic pricing options—i.e., charging customers electricity rates that reflect the changing price of generating electricity. Dynamic electricity pricing options include time-of-use pricing, real-time pricing, and peak pricing, among others, and incentivize consumers to either shift consumption to times of high renewables generation or curtail consumption in times of constrained supply. With demand response programs, utilities and regional operators can reduce peak capacity requirements by creating markets and systems that allow electricity demand to respond in real time to supply conditions. Increasingly widespread demand response approaches include (but are not limited to) direct load programs, under which the utility pays customers a credit to remotely and temporarily control some of their equipment, and load curtailment programs, in which customers commit to curtail some load in periods of high demand with notice from the utility. These flexible load investments are a cheaper, more rapidly deployable, and less polluting way of meeting peak capacity requirements than building new natural gas-fired plants.[45] Demand response programs can also result in utility bill savings: by shifting electricity demand to non-peak hours, demand response reduces the need to run expensive and polluting generators that would have otherwise been dispatched to meet high demand. A study by the Southeast Partnership for Energy Efficiency as a Resource (SPEER) found that a modest amount of demand response could have saved Texas consumers more than $200 million over just five days in 2012 and 2013 when demand was higher than average.[46] In addition, the Brattle Group completed a report for Texas's grid operator, ERCOT, in which it found that if a voluntary critical peak pricing plan (i.e., a pricing plan with a very high "super peak" price but lower prices during normal and off-peak hours) was offered in the Texas residential retail market, it would likely result in 1074 MW of demand reduction—40% of Texas's current demand response portfolio—during grid emergencies.[47] Baltimore Gas & Electric's (BGE) Smart Energy Rewards demand response initiative is another testament to the success of simple, device-free behavioral programs in engaging customers and motivating them to reduce their peak electricity usage based on feedback on their energy consumption. The program delivered more than $7 million in bill savings for BGE customers in its first year, leading the utility to expand it to 800,000 customers, roughly three times the size of the initial pool.[48] The Rocky Mountain Institute (RMI) estimates that being able to control the timing of residential air-conditioning and electric water heaters could reduce U.S. peak load by 8% without compromising comfort or service quality.[49] The RMI study also found that shifting eligible loads across the hours of a day to times when electricity cost is lower represents a large, cost-effective, and untapped opportunity to reduce customer bills and grid costs. In fact, RMI found that load shifting in residential programs alone could deliver substantial net bill savings of 10 to 40% annually for customers across four utility territories, as well as $13.3 billion in avoided grid costs (from generation, transmission, distribution, and energy arbitrage, among other things). Distributed storage options will also have an important role to play in balancing and reinforcing a renewable dominated grid. Bloomberg New Energy Finance projects that as battery technology evolves, battery costs will fall 66% in the next 15 years; they will be commonly installed alongside rooftop solar by 2020 and cost-competitive with peaking natural gas combustion turbines by 2030 when installed with solar panels.[50] And in the near term, smart markets can enable electric vehicles, as well as our heating and cooling systems, to store energy from peak renewable generation times.[51] For instance, the Brattle Group notes that "electric water heaters are essentially pre-installed batteries that are sitting idle in more than 50 million homes across the U.S."[52]; In fact, when the wind is blowing or the sun is shining, large water heaters can be enabled to make immediate use of that clean energy to heat water to high temperatures. The water heaters can then be shut down when renewables are scarce and/or wholesale power prices are high. By scaling up these existing resources and strategies, we can maintain a strong, reliable electricity grid while integrating large amounts of renewable power. In a new "Trends to Watch in Alternative Energy" report, Deloitte further notes the potential of distributed renewables to contribute to resiliency as more extreme weather events threaten to increase outages in a grid that is reliant on large base-load fossil fuel plants.[53]

5. Clean energy: a hedge against the environmental and price volatility risks associated with natural gas

By replacing retiring coal plants with increased efficiency, renewable energy, and innovative grid management – rather than building out natural gas pipelines and power plants and drilling for more gas to

[39] Jim Malewitz, $7 Billion CREZ Project Nears Finish, Aiding Wind Power, Texas Tribune, October 2013; Robert Walton, ERCOT: Time to Build More Transmission in Texas Panhandle September 2015; Jurgen Weiss and Bruce Tsuchida, Integrating Renewable Energy into the Electricity Grid: Case Studies Showing How Operators Are Maintaining System Reliability, The Brattle Group, June 2015.

[40] Paul Denholm, Kara Clark, and Matt O'Connell, Emerging Issues and Challenges in Integrating High Levels of Solar into the Electrical Generation and Transmission System, National Renewable Energy Laboratory, May 2016.

[41] Southwest Power Pool, 2016 Wind Integration Study, January 2016.

[42] Alexander E. MacDonald et al. Future Cost-Competitive Electricity Systems and Their Impact on US CO2 Emissions, Nature Climate Change 6 (January 2016): 526–531.

[43] Ibid.

[44] Aaron Bloom et al., Eastern Renewable Generation Integration Study, National Renewable Energy Laboratory, August 2016.

[45] Northwest Power and Conservation Council, Seventh Northwest Conservation and Electric Power Plan.

[46] Katherine Tweed, Demand Response Could Have Saved Texans $85 M in One Day, GreenTech Media, June 2015.

[47] Ibid.

[48] Opower, Utilities in Three Major ISOs to Deploy Opower's Behavioral Demand Response Solution This Summer, May 2014.

[49] Peter Bronski et al., The Economics of Demand Flexibility: How 'Flexiwatts' Create Quantifiable Value for Customers and the Grid, Rocky Mountain Institute, August 2015.

[50] Seb Henbest et al., New Energy Outlook 2016, Bloomberg New Energy Finance, June 2016.

[51] NRDC, Driving Out Pollution: How Utilities Can Accelerate the Market for Electric Vehicles, June 2016; Office of the President of the United States, Incorporating Renewables into the Electricity Grid: Expanding Opportunities for Smart Markets and Energy Storage, June 2016.

[52] Ryan Hledik, Judy Chang, and Roger Lueken, The Hidden Battery: Opportunities in Electric Water Heating, The Brattle Group, January 2016.

[53] Deloitte, Trends to Watch in Alternative Energy, February 2016.

supply them – we can avoid locking in a fossil-reliant energy future.[54] A build-out of clean energy resources will result in significant social, environmental, and economic benefits while minimizing the production and use of natural gas and the attendant public health and environmental impacts. The environmental risks of unconventional gas extraction, or hydraulic fracturing, are well documented, but there are also important concerns associated with natural gas-fired power plants, including their disproportionate impacts on disadvantaged communities located nearby or downwind.[55] Further, emissions from natural gas are a significant contributor to climate change, especially relative to carbon-free clean energy alternatives. Natural gas plants may emit only half (roughly) of the carbon dioxide emissions of coal plants, but the amount is still significant, and the process of extracting and transporting natural gas results in dangerously large emissions of methane—a greenhouse gas even more potent than carbon dioxide.[56] What is more, natural gas production has been increasingly associated with environmental hazards. The two recent Oklahoma earthquakes that hit the same area about two months apart have been linked to the underground disposal of wastewater from oil and natural gas production and drove the state to shut down 37 wastewater wells connected to such production.[57] In October 2015, one of the biggest methane leaks in U.S. history occurred at a natural gas storage field near Los Angeles, which the Environmental Defense Fund estimates to have a 20-year climate impact equivalent to burning nearly a billion gallons of gasoline.[58] In sum, simply replacing coal with natural gas would severely undermine our ability to avoid the worst impacts of climate change and achieve our near-, medium-, and long-term climate commitments.[59] Last, unlike clean energy alternatives, natural gas plants are vulnerable to commodity price shocks that can have acute consumer impacts. Since the early 1990s, natural gas prices have been notoriously volatile, with large price swings tied to extreme weather events, high demand, and uncertainties about gas supplies. Customers in states that rely more heavily on natural gas plants are exposed to these price swings, especially in the winter months when demand is strong. For example, the 2014 polar vortex across the country led to spiking electricity and natural gas prices in the gas-reliant Northeast as the competing natural gas demand for heating and electricity generation exceeded supplies.[60] Therefore, relying less on natural gas and investing in renewable energy and energy efficiency is an effective—and well-demonstrated—hedge against potential increases in gas prices and spikes in electricity and heating bills. New natural gas infrastructure investments also saddle energy customers with the substantial risk that in a future of higher natural gas prices and/or stronger limits on carbon emissions, those investments will become increasingly uneconomical—and ultimately stranded— assets.[61] In the face of the multiple uncertainties, reliance on gas is a risky strategy. It could make it impossible for us to meet the greenhouse gas reductions that the prevailing science says we need in order to mitigate the most severe impacts of climate change, and it would have significant negative impacts on the economy.[62]

6. Regional opportunities for clean energy expansion

Next, we'll explore energy efficiency, clean energy, and grid modernization opportunities in the three U.S. regions—the Mid-Atlantic (PJM), the Midwest (MISO), and the Southeast—where most coal plant retirements have occurred or will occur in the years ahead. These are currently the three most coal-heavy regions in the country and have significant opportunities for making clean energy progress.

6.1. PJM

The Pennsylvania-New Jersey-Maryland Interconnection is a regional transmission organization covering all or part of 13 northeastern states as well as the District of Columbia. Historically, the PJM region has both produced and burned a significant amount of coal. In 2015, four PJM states—West Virginia, Kentucky, Pennsylvania, and Illinois—accounted for 31% of all U.S. coal production, and PJM states accounted for roughly 20% of U.S. coal-fired generation. With cheap natural gas from Pennsylvania, West Virginia, and Ohio outcompeting coal, the PJM region has seen the majority of the nation's coal plant retirements over the past few years, coupled with a rush to natural gas plant build-outs to meet capacity needs. From 2012 to 2015, 16 GW of coal capacity retired in PJM—equivalent to almost 9% of the region's 2012 total generating capacity and 6% of its 2012 total generation.[63] Meanwhile as of fall 2016, PJM reported 20 GW of new natural gas plants under construction in its territory, all of which is expected to come online in the next few years. Moreover, an additional 18 GW of natural gas plants have been announced or are in early development in the region.[64] For the past four years, the trend in PJM has been for new gas generation to replace retiring coal generation on a near one-to-one basis. For the reasons discussed above, continuing this trend would be a grave mistake for the region. Fortunately, PJM can still reverse course in favor of cleaner and more cost-effective solutions. With its enormous unrealized potential for both energy efficiency and renewable energy, the PJM states have clean alternatives to more baseload natural gas generation. First, utilities can significantly cut power needs in the face of coal retirements by investing in energy efficiency programs. Commitment to energy efficiency varies widely across the PJM region, where more than half of the states don't have an EERS in place and have consequently achieved low levels of efficiency savings in the past years. In fact, only three states in PJM (Illinois, Michigan, and Maryland) achieved energy savings exceeding 1% of sales in 2015. Compared with annual savings of over 3% that the highest-performing states have achieved, the PJM region has significant untapped potential for greater energy savings in the region (Fig. 3).

For example, in Ohio, while policymakers were busy freezing the state's EERS and RPS in 2014 for a two-year period, an efficiency potential study estimated that the utility AEP Ohio could achieve up to 37% cost-effective cumulative energy savings between 2015 and 2030 (more than 2% per year) with a comprehensive, portfolio that includes investments in new multifamily construction and home retrofit

[54] Note that there is already excess capacity in many states retiring coal generation, so not all the retired coal capacity needs to be replaced. There is also always the possibility of relying more on existing natural gas plants in the short term, rather than building new natural gas plants (as in the Northwest Power Plan).

[55] Tanja Srebotnjak and Miriam Rotkin-Ellman, Fracking Fumes: Air Pollution from Hydraulic Fracturing Threatens Public Health and Communities, NRDC, December 2014; PSE Healthy Energy, The Clean Power Plan in Pennsylvania: Analyzing Power Generation for Health and Equity, June 2016.

[56] Garvin Heath et al., Estimating U.S. Methane Emissions from the Natural Gas Supply Chain: Approaches, Uncertainties, Current Estimates, and Future Studies, National Renewable Energy Laboratory, August 2015; A Close Look at Fugitive Methane Emissions from Natural Gas, World Resources Institute, April 2013.

[57] Jackie Wattles and Matt Egan, Oklahoma Orders Shutdown of 37 Wells After Earthquake, CNN, September 2016; Chicago Tribune, Another Earthquake Hits Oklahoma Area Shook by Major Temblor, Nov. 2, 2016.

[58] Environmental Defense Fund, Aliso Canyon Leak Sheds Light on National Problem.

[59] Jeff Deyette et al., The Natural Gas Gamble: A Risky Bet on America's Clean Energy Future, Union of Concerned Scientists, March 2015; Rating the States on Their Risk of Natural Gas Overreliance, October 2015.

[60] EIA, Market Digest: Natural Gas (2013–2014), June 2014; Sam Gomberg, Jeff Deyette, and Sandra Sattler, Charting Michigan's Renewable Energy Future, Union of Concerned Scientists, March 2014.

[61] Mark Bolinger, Revisiting the Long-Term Hedge Value of Wind Power in an Era of Low Natural Gas Prices, Lawrence Berkeley National Laboratory, March 2013.

[62] The Brattle Group, Including New Gas-Fired Combined Cycle Plants in State Clean Power Plan Compliance Could Lower System Costs of Achieving Carbon Reduction Goals, According to Brattle Economists, November 2016.

[63] SNL's power sector data set logs 15.97 GW of retired coal plants in the PJM service territory from 2012 to 2015, compared with 185.6 GW of generating capacity cited in PJM's 2012 report.

[64] SNL Database, Power Plant (Units) Projects for the PJM Interconnect, last updated 2016.

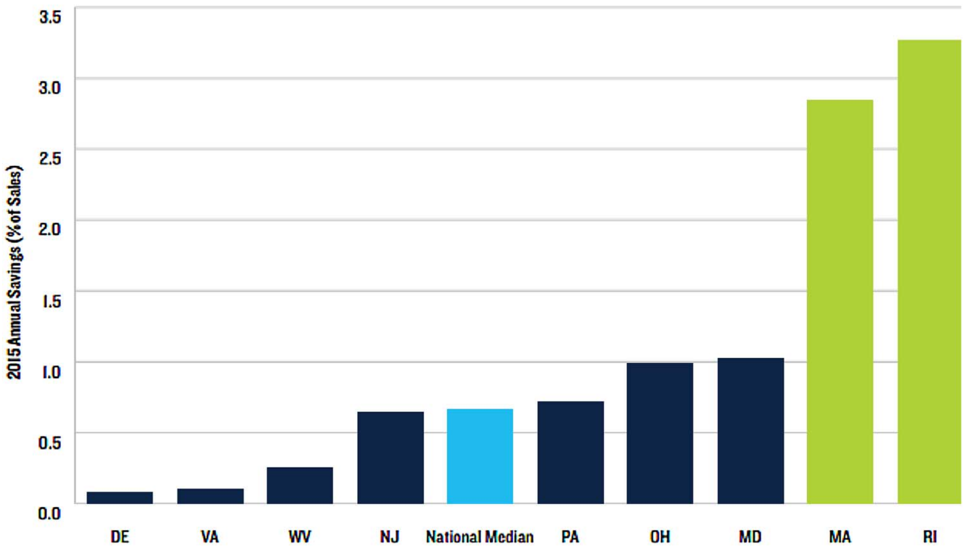


Fig. 3. 2015 Annual Electricity Savings as a Percentage of Retail Sales for Selected PJM States (Dark Blue), National Median (Light Blue), And Leading States (Green). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

programs and deployment of combined heat and power technologies and LED lighting in homes and business.[65] Now that the two-year freeze has come to an end, Ohio is poised to be back in the clean energy game, as Gov. Kasich vetoed a bill in December 2016 that would have significantly weakened the state's clean energy standards by making them voluntary. The RPS and EERS are now back in effect as of Jan. 1, 2017, and the state's investor-owned utilities are expected to restart and scale up investments in renewable energy and energy efficiency, delivering good jobs, millions in investments, and a healthy environment while saving Ohioans millions on their utility bills.[66] In fact, in vetoing the bill, Gov. Kasich stated that delaying reinstatement of the clean energy standards would have "amounted to self-inflicted damage to both our state's near- and long-term economic competitiveness."[67]; And in Pennsylvania, a conservative 2015 study of efficiency potential conducted by the state's Public Utility Commission concluded that between now and 2021, Pennsylvania's largest electric utilities could cost-effectively achieve more than twice the level of efficiency savings that will be required under the state's EERS (Act 129 of 2008). Why the difference? Because in its current form, Act 129 arbitrarily caps (at 2% of 2006 sales) the amount that utilities can be required to spend on their statutory efficiency programs. This effectively prohibits them from achieving all the cost-effective savings they otherwise could. The problem is compounded by the fact that Pennsylvania law has neither revenue decoupling for electricity sales (which would largely remove the financial incentive for utilities to sell as much electricity as possible) nor affirmative incentives for utilities.[68] Despite the weak investments in energy efficiency, the PJM system operator is showing signs of increasingly valuing efficiency as a reliable energy resource similar to natural gas, nuclear, and renewables. In fact, PJM operators paid utilities and efficiency providers to reduce electricity demand by more than 1500 MW three years from now in its latest capacity auction.[69] The results of the auction underscore the confidence of system planners in energy efficiency's ability to reliably meet electricity demand in a climate of significant coal retirements.[70] The increasing amount of efficiency bidding into the PJM market is also expected to deliver significant economic savings to millions of customers in the PJM region, as efficiency is edging out much more expensive generators that otherwise would have been paid to supply power in the future.[71]

The PJM region can exponentially scale up renewable energy generation. While solar and wind generation accounted for only 2.7% of total generation in the first half of 2016, a conservative estimate by General Electric in a study commissioned by PJM found that the PJM grid can reliably support *10 times* more renewable energy than is currently operating, while lowering consumer costs and harmful pollution. Indeed, the study concluded that with adequate planning for transmission and the regulation of reserves, PJM could reliably integrate 30% variable renewable generation into its portfolio by 2026—enough to power close to 24 million homes annually—and that it is well equipped to grow its share of renewable energy 10-fold over the next 15 years.[72] These studies demonstrate that PJM's transition to a clean energy system not only is possible but is also likely to deliver significant economic and environmental benefits.

6.2. MISO

The Midcontinent Independent System Operator covers 15 U.S. states over a significant geographical area, from North Dakota to Louisiana, with a portion of its footprint extending into Canada..[73] Especially in its North and Central regions, MISO has historically been coal-dependent, with coal generation making up between 73 and 65% of total generation between 2009 and 2012, respectively, across its U.S. footprint.[74] But change is underway. The percentage of coal in the generation mix declined to 51% in 2015, with aging coal plants being edged out economically by cheap shale gas, copious wind resources,

[65] AEP Ohio, Volume 1: 2015 to 2019 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan, March 2014; Maggie Molina and Neal Elliott, Energy Efficiency Potential in Ohio, ACEEE, August 2015.

[66] David Roberts, Ohio Gov. John Kasich just saved his state's clean energy standards, Vox, December 2016; Timothy Cama, Kasich vetoes bill to weaken clean energy mandate. The Hill, December 2016.

[67] John Funk, Kasich vetoes bill that would have made renewable energy voluntary, opens the door to comprehensive energy reform, December 2016.

[68] In fact, this is just the tip of the iceberg for Pennsylvania. The state could also increase the efficiency of its electricity use by (among other things) updating its process for adopting new building codes and expanding the use of combined heat and power (CHP) systems. Current state law requires new buildings to meet only 2009 efficiency standards, and a recent study found that Pennsylvania ranked fifth among all states in the amount of carbon pollution that could be reduced through expanded use of CHP in its industrial sector. Alliance 4 Industrial Efficiency, Pennsylvania's Carbon Dioxide Pollution Could Be Dramatically Reduced with Industrial Energy Efficiency and Combined Heat and Power, October 2016.

[69] George Katsigiannakis and Himanshu Pande, PJM 2019/2020 Capacity Auction Analysis, ICF, International, July 2016.

[70] Brendon Baatz, Energy Efficiency Lowers Costs in Recent PJM Capacity Auction, ACEEE, June 2016.

[71] Ibid.

[72] GE Energy Consulting, PJM Renewable Integration Study, February 2014.

[73] The MISO footprint also extends to regions in Canada. In this article, the discussion is limited to the United States

[74] SNL Database, MISO Generation Data for 2009 and 2012.

and rapidly declining wind generation costs, as well as stricter environmental regulations, including the Environmental Protection Agency's Mercury and Air Toxics Standards (MATS) and Cross-State Air Pollution Rule (CSAPR). And coal is expected to supply only 36% of MISO demand in 2030 as plants continue to retire for economic reasons.[75] In Michigan, for instance, 25 coal units totaling 2230 MW in capacity – equivalent to about 20% of the state's coal capacity, and more than 8% of the state's total generation in 2015- will be retired by 2020.[76] Eight more coal-fired units are scheduled to retire by 2023.[77] DTE Energy, the largest utility in Michigan, will have shut down 11 of its 17 coal-fired units by 2023 and will be coal-free by 2040 as a consequence of the above factors. The utility also recently announced its plans to increase its renewable capacity *six-fold* compared to its currently owned renewables[78] In similar fashion to PJM, the MISO region has significant opportunities to scale up its energy savings and clean energy generation to replace retiring coal capacity and deliver large benefits to customers in its footprint. Over MISO's large geographical territory, energy efficiency policies are mixed. Michigan, Minnesota, and Iowa have energy efficiency resource standards in place and above average incremental energy savings of 1.05%, 1.21%, and 1.18%, respectively, as of 2015 (with Iowa and Michigan meeting and exceeding their EERS).[79] Illinois will have one of the top energy efficiency programs in the U.S. when the recently passed energy legislation is enacted. The bill requires—among other provisions to incentivize efficiency investments—laudable efficiency achievements for the state's two largest utilities, requiring ComEd and Ameren to achieve an impressive 21.5% and 16% reduction in energy use by 2030, respectively, and it requires a minimum $25 million per year to be spent exclusively on programs to increase the efficiency of low-income households for ComEd customers.[80] Conversely, North Dakota and Louisiana achieved near-zero electricity savings, with less than 0.1% incremental savings in 2015. In fact, almost half of the states in the U.S. MISO footprint don't have an EERS in place, and the average 2015 incremental savings across four states did not exceed 0.3% (Fig. 4).[81] Lower-performing states can begin to deliver bill savings to their customers by ramping up efficiency programs and putting the right regulations in place (including an EERS, decoupling, and timely cost recovery mechanisms). Leading states like Michigan and Illinois have recently passed energy legislation removing or loosening the spending caps on efficiency, allowing significantly larger investments. The cap was loosened in Illinois, and although this is a noticeable improvement, the state should follow Michigan's lead and remove the spending cap on efficiency, instead directing utilities to deploy efficiency whenever it is cost-effective spending. The renewable energy transition is already well underway in some parts of the region. In the first half of 2016, wind power provided 8.2% of MISO's demand, compared with 7.2% and 6.9% in the first half of 2015 and 2014, respectively.[82] This trend is expected to hold, as MISO's rich wind resource base is expected to drive rapid growth in wind generation. In fact, the 2020 wind capacity in MISO is projected to increase by 67% compared with 2015, reaching approximately 28 GW, due to planned and under-construction projects. In Iowa, where wind generation makes up more than 30% of the fuel mix, utilities are continuing to make substantial clean energy investments. The utility Alliant Energy is on the verge of more than doubling its wind capacity and is expected to own and operate 700 MW of wind capacity by 2020 while still purchasing another 600 MW of wind from other facilities.[83] MidAmerican Energy is on track for 85% renewable generation with its plan to build the nation's largest wind installation by 2019 (totaling 2 GW).[84] These laudable efforts will enable Iowa to reach and exceed the 40% renewable generation mark before any other state in the nation. The in-state 2020 wind capacity will increase by nearly 64% compared with 2015, exceeding 10 GW installed capacity. This is a faster growth rate than the rate achieved between 2010 and 2015, when in-state wind capacity increased by roughly 40%. In Minnesota, Xcel Energy's newest integrated resource plan (IRP) calls for the utility to retire two coal units representing more than 1300 MW in capacity at its Sherburne County Power Plant—the largest coal plant in the state—and replace the lost capacity with 1.8 GW of wind and 1.4 GW of solar by 2030.[85] This renewable investment would effectively increase Xcel's managed wind capacity in the upper Midwest by roughly 80%. While the Public Utilities Commission (PUC) approved Xcel's renewable builds, it did not approve the rest of its replacement solution, which included building a large gas-powered generation plant; instead, the PUC directed Xcel to study renewable energy alternatives and demand-side management opportunities.[86] Minnesota can go even further in its transition to a cleaner energy system. A study conducted by all of the state's utilities and transmission companies found that wind and solar could reliably supply at least 40% of the state's electricity, even as surrounding states including Wisconsin, Michigan, Illinois, Indiana, and Missouri achieve their RPS. Moreover, if each of these five states were to meet its respective RPS requirement, the amount of wind and solar generation would amount to 15% of the five-state total generation.[87] The study also concluded that there is still significant and untapped renewable potential for the MISO North/Central region. In Michigan, lawmakers recently passed energy legislation raising the state RPS from 10% to 15% by 2021. The new standard is expected to boost renewable energy deployment in the state after two years of lukewarm clean energy investments.[88] And by addressing the problems that thwarted steady funding to renewable projects, the recently passed energy legislation in Illinois will open the door to wind and solar development and finally put the state on solid track to meet its impressive goal of meeting 25% of its electricity demand with renewables by 2025.[89] Both states are now expected to scale up their investments in renewable energy, delivering significant economic benefits to their residents mirroring those that the states have already reaped from their existing wind projects.

One additional resource available in MISO to improve system reliability and better integrate clean energy is demand response. In the face of tightening supply and increased reliability risks, demand response is still rarely called upon in MISO due to various regulatory barriers.[90] In fact, the Federal Energy Reliability Council (FERC) has

[75] Transmission Hub, 'MISO Energy Mix 51% Coal in 2015; Expected to Decline to 36% in 2030, April 2016.

[76] J.C. Reindl, 25 Michigan Coal Plants Are Set to Retire by 2020, Detroit Free Press, October 10, 2015.

[77] 3 Based on 2014 coal capacity of 10,948 MW, see EIA, Michigan Electricity Profile 2014, March 2016.

[78] http://www.crainsdetroit.com/article/20170516/NEWS/170519864/dte-energy-plans-to-be-coal-free-by-2040.

[79] Savings calculated using EIA Form 861 Sales and Savings Data for 2015. See EIA (2016). Electric power sales, revenue, and energy efficiency Form EIA-861 detailed data files.

[80] 5 Tina Sfondeles, Massive energy bill headed to governor's desk, Chicago Sun Times, December 2016; Nick Magrisso, Future Energy Jobs Bill: A Path for Illinois to a Bright Clean Energy Economy, NRDC, December 2016.

[81] Savings calculated using EIA Form 861 Sales and Savings Data for 2015. See EIA (2016). Electric power sales, revenue, and energy efficiency Form EIA-861 detailed data files.

[82] MISO, Monthly Market Reports, January–June 2014, 2015.

[83] SNL database, Generating Capacity by Utility, 2020.

[84] Donnelle Eller, MidAmerican Energy Aims for 85% Wind Power, Des Moines Register, April 15, 2016.

[85] Mike Hughlett, State Regulators Approve Xcel's Plan to Shut Down Becker Coal-Fired Plants, Star Tribune, Oct. 13, 2016.

[86] Ibid.

[87] Minnesota Department of Commerce, Report in the Matter of the Integration and Transmission Study for the Future Renewable Energy Standard Required by Minnesota Law, November 2014.

[88] Julia Pyer, Michigan Passes Legislation to Boost Renewables Mandate, Retain Net Metering, GreenTech Media, December 2016.

[89] Julia Pyer, Clean Energy Advocates Praise Passage of Major Illinois Energy Bill, GreenTech Media, December 2016, https://www.greentechmedia.com/articles/read/clean-energy-advocates-praise-passage-of-major-illinois-energy-bill; Nick Magrisso, Future Energy Jobs Bill: A Path for Illinois to a Bright Clean Energy Economy, Natural Resources Defense Council, December 2016.

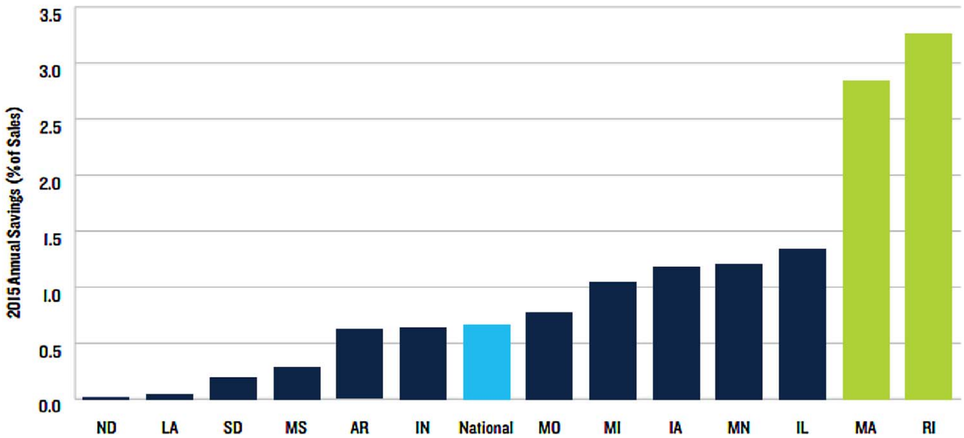


Fig. 4. 2015 Annual Electricity Savings as a Percentage of 2015 Retail Sales for MISO States (Dark Blue), National Median (Light Blue), and Leading States (Green). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

estimated a large untapped potential for demand response in MISO states, amounting to nearly 15% of peak demand.[91] This is significantly more than what currently exists; in its most recent planning resource auction results, MISO reported that the amount of demand response available to MISO states between June 2016 and May 2017 makes up only 6% of last year's average peak demand over the same period.[92] One notable example of how demand response programs (in this instance, large-scale industrial demand response) can benefit the electricity grid in MISO can be found at the Alcoa facility in Warrick, Ind. This facility provides 70 MW of aluminum smelter load as flexible demand, which goes up and down in response to system conditions, such as an increase or drop in wind generation. Alcoa also provides an additional 150 MW of interruptible spinning reserves—i.e. load that can be interrupted during emergency operating conditions and unforeseen load swings – which can significantly reduce load when the grid is stressed by high demand and maintain reliability.[93] It's smart business for Alcoa and provides valuable services to the whole grid, more cost-effectively meeting peak demand and replacing the need to build new peaking plants.

6.3. Southeast

Unlike the organized regional markets of MISO and PJM, the Southeast is primarily made up of independent, vertically integrated utilities that independently dispatch energy and manage reliability within each utility's load zones. This section focuses on the southeastern states of Alabama, Florida, Georgia, Tennessee, and the Carolinas. Close to 12,000 MW of coal capacity was retired between 2012 and 2015 in these states—20% of their 2012 total—with Georgia retiring 18% of its coal capacity in 2015 alone.[94] As in MISO and PJM, this trend is expected to continue over the coming decade, as close to an additional 7000 MW of coal plants are earmarked for retirement across these states between 2016 and 2025. The Southeast has significant clean energy and energy efficiency potential that states can tap into to replace retiring coal capacity.[95] There is especially large potential in energy efficiency, as the region consistently ranks low on ACEEE's State Energy Efficiency Scorecard.[96] In fact, North Carolina is the only state among the six southeastern states we are evaluating here with a semblance of an EERS, as energy efficiency savings count toward compliance with the state's RPS. The absence of energy efficiency requirements justify the small utility energy efficiency investments in the region: In 2015, median energy efficiency investment for the six Southeast states was 0.54% of utility revenue, less than half the national median of 1.3%. Electricity savings across the region have mirrored the weak investments in energy efficiency: In 2015, the median incremental electricity savings for the six Southeast states amounted to less than 0.3%, noticeably lower than the already modest national median of 0.67% (Fig. 5).[97] Among these states, Florida and Alabama have yet to exceed the 0.1% incremental savings mark. The minimal investment in energy efficiency across the region has directly contributed to the high energy burdens (percent of household income spent on energy) identified across cities in the Southeast. In fact, a recent report from ACEEE, NRDC, and Energy Efficiency for All found that the Southeast region had the highest median energy burden (average burden among the groups analyzed) of all regions.[98] Southeast states can and should exponentially scale up energy efficiency investments by implementing clear efficiency goals and standards and designing a supportive regulatory environment that ensures that utilities have the support to maintain sustained investment in efficiency. The Southeast Energy Efficiency Alliance (SEEA) recommends that the Southeast states pursue revenue decoupling, program cost recovery, and performance incentives, a sound and widely proven framework for improving energy efficiency.[99] In fact, Arkansas (another Southeast state) has both an EERS and a similar regulatory framework in place, and this combination has more than tripled electricity savings from statewide, utility-operated efficiency programs between 2011 and 2015.[100] SEEA has also created a best practices guidebook for Quick Start efficiency programs in the Southeast, which are a set of easy-to-implement programs that achieve savings in a short period while laying the foundation for comprehensive portfolio growth in future years. Programs include offering rebates for the purchase of efficient lighting and appliances, and providing energy efficiency audits for larger commercial and industrial

[90] Katherine Tweed, Does the Midwest Need Demand Response? GreenTech Media, April 2016.

[91] The Brattle Group, Freeman, Sullivan & Co., and Global Energy Partners, LLC, A National Assessment of Demand Response Potential, prepared for the Federal Energy Regulatory Commission (FERC), June 2009.

[92] Ibid.

[93] DeWayne Todd, They Said It Couldn't Be Done: Alcoa's Experience in Demand Response, Alcoa, July 2013.

[94] EIA, Coal Made Up More Than 80% of Retired Electricity Generating Capacity in 2015.

[95] Joyce McLaren, Southeast Regional Clean Energy Policy Analysis, National Renewable Energy Laboratory, 2011.

[96] ACEEE, The State Energy Efficiency Scorecard. In 2015, Tennessee and Florida ranked 25th, and Alabama, North Carolina, South Carolina, and Georgia ranked 39th, 30th, 40th and 35th, respectively.

[97] Annie Gilleo et al., The 2015 State Energy Efficiency Scorecard.; AEP Ohio, VOLUME 1: 2015 TO 2019 ENERGY EFFICIENCY/PEAK DEMAND REDUCTION (EE/PDR) ACTION PLAN, March 2014; Median savings calculated using EIA Form 861 Sales and Savings Data for 2015. See EIA (2016). Electric power sales, revenue, and energy efficiency Form EIA-861 detailed data files.

[98] Ariel Drehobl and Lauren Ross, Lifting the High Energy Burden.

[99] ACEEE, Aligning Utility Interests with Energy Efficiency Objectives: A Review of Recent Efforts at Decoupling and Performance Initiatives, October 2006.

[100] 3 Katie Southworth and Abby Schwimmer, Southeastern Utility Program Ramp-Up Rates, Southeast Energy Efficiency Alliance, April 2015.

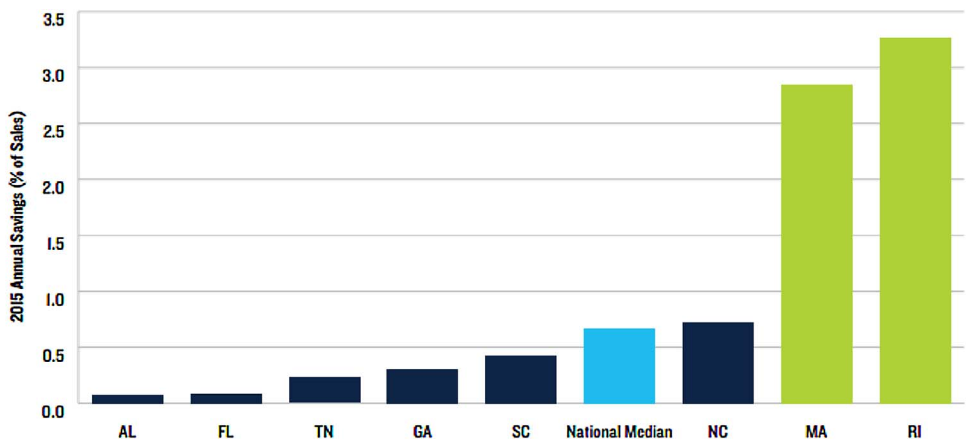


Fig. 5. 2015 Annual Electricity Savings as a Percentage of 2015 Retail Sales for Southeast States (Dark Blue), National Median (Light Blue) and Leading States (Green). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

customers followed by incentives for making efficiency improvements, among many others.[101] The Southeast region is endowed with abundant renewable energy resources that some states are already starting to tap into. North Carolina, the only state in the Southeast with a RPS, already has more than 2 GW of solar capacity installed, the second-most of any state in the country.[102] Georgia now appears to be following suit, with Georgia Power set to build 1.2 GW of new renewable capacity by 2021 (mostly solar energy), including 150 MW of distributed generation by the end of 2018. There is currently 161 MW of installed solar capacity statewide.[103] In 2015, Georgia also became the first state in the Southeast to approve of third-party ownership of rooftop solar power, i.e. someone else can own the solar panels on a homeowner's rooftop, and solar power can be sold to someone other than the utility. Third-party ownership is poised to accelerate an already booming solar industry in Georgia.[104] (For context, third-party-owned systems make up 60–90% of new residential rooftop systems in Arizona, Colorado, California, and Massachusetts.[105]) In the rest of the Southeast, either the law is silent with regards to third-party ownership of solar or, in the case of North Carolina and Florida, the practice is barred outright. In fact, a spokesperson for the solar services company SolarCity dubbed Florida the "sleeping giant" of the rooftop industry, given the combination of the Sunshine State's very large solar potential and its extensive rules that thwart investments in rooftop solar panels.[106] It is worth noting that South Carolina passed legislation in 2014 that allows third-party solar leasing.[107] This has begun to remove significant barriers for solar energy in the state and has already opened the market for companies like SolarCity, which recently launched a residential solar service in South Carolina offering attractive loan options for the installation and proper operation of residential rooftop solar.[108] New evidence continues to demonstrate that replacing coal with energy efficiency and renewable power rather than natural gas could save money for electricity consumers in the South. A recent paper from Georgia Tech compared two possible future pathways by which southern states could meet the emissions limits of the U.S. Environmental Protection Agency's Clean Power Plan: One pathway relied on increased natural gas generation, and the other implemented energy efficiency and solar policies instead.[109] Relying on efficiency and solar energy investments resulted in 14% lower average electricity bills by 2030 compared to the natural-gas-heavy alternative. Southeastern states stand to reap considerable economic benefit from clean energy and efficiency if utilities and local governments put policies in place that encourage cost-effective investments in utility-scale renewables, and repeal the rules designed to block homeowners from tapping into the region's copious sunshine to generate power.

7. Conclusion

Coal retirements around the country offer a unique opportunity to transition to a lower-emitting, more dynamic, cost-effective, and resilient electricity system while delivering economic benefits to households and businesses. Expanding natural gas generation and supporting pipeline and compressor infrastructure would be a significant setback to efforts to achieve the ambitious emissions reductions needed to avoid dangerous climate change and would also expose American households and businesses to increased risk of price shocks and stranded assets. Instead, all states can and should strengthen energy efficiency and renewable standards and associated clean energy investments. States should also engage in smart planning and regulatory reform where necessary to facilitate investments in a more flexible grid. The transition to clean energy is already in progress. As fossil fuels grow more obsolete, energy efficiency, renewable energy and a more integrated, responsive grid will move the nation toward a more affordable and reliable clean energy future.

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[101] Abby Schwimmer and Ashley Fournier, Energy Efficiency Quick Start Programs: A Guide to Best Practices, Southeast Energy Efficiency Alliance, April 2014.

[102] Bruce Henderson N.C. Jumps to Second Place for Solar Energy, Charlotte Observer, Sept. 15, 2016.

[103] Dave Williams, Georgia Power Agrees to Major Commitment to Renewables, Atlanta Business Chronicle, June 24, 2016.

[104] While Georgia now approves of third-party ownership, it still doesn't have net metering, a statewide mechanism for reimbursing customers for excess electricity generation. This constitutes another barrier to the expansion of rooftop solar in the state.; Christa Owens Michelet, In The Southeast, Could Third-Party Ownership of Solar Power Be Taking Root? Rocky Mountain Institute, June 2015.

[105] David Feldman and Travis Lowder, Banking on Solar: An Analysis of Banking Opportunities in the U.S. Distributed Photovoltaic Market, National Renewable Energy Laboratory, November 2014.

[106] Evan Halper, Rules Prevent Solar Panels in Many States with Abundant Sunlight, Los Angeles Times, Aug. 9, 2014.

[107] Sammy Fretwell Haley Signs Bill to Ease Restriction on Solar Energy, The State, August 2014.

[108] SolarCity, SolarCity Launches Residential Service for South Carolina, October 2016.

[109] Marilyn A. Brown, Alexander Smith, and Gyungwon Kim, The Clean Power Plan and Beyond, Georgia Institute of Technology, June 2016. Note that this study employs a different definition of the South, including four divisions of the Southeast Reliability Council (SRDA–Mississippi Delta, SRCE–Tennessee Valley, SRSE–Georgia Alabama, and SRVC–Virginia-Carolina), SPPS–Southern Plains, TRE–Texas, and FRCC–Florida.

analyses. Her work is focused on advancing clean energy policies in Midwest states by supporting utility climate action and helping companies reduce their carbon footprints. Fakhry also works on various analyses and materials supporting strong federal energy efficiency policies and supports NRDC's advocacy efforts on maintaining and strengthening the U.S. Department of Energy's budget for clean energy R & D. She holds a bachelor's degree in Civil and Environmental Engineering from the American University of Beirut and a master's degree in Management Science and Engineering from Stanford University.